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PHASE II
SAMPLING AND ANALYSIS PLAN
FOR OPERABLE UNIT 3
LIBBY ASBESTOS SUPERFUND SITE

PART C: SAMPLING AND ANALYSES TO SUPPORT ECOLOGICAL RISK ASSESSMENT

1.0 PROJECT OVERVIEW

1.1 Purpose of this Document

This document is Part C of the Phase II Sampling and Analysis Plan (SAP) for the collection and analysis of samples to support a remedial investigation/feasibility study (RI/FS) within Operable Unit 3 (OU3) of the Libby Asbestos Superfund Site near Libby, Montana. OU3 includes the property in and around the former open pit vermiculite mine that is located northeast of the community of Libby, as well as the geographic area surrounding the former vermiculite mine that has been impacted by releases and subsequent migration of hazardous substances and/or pollutants or contaminants from the mine, including ponds, Rainy Creek, Carney Creek, Fleetwood Creek, and the Kootenai River. Rainy Creek Road is also included in OU3. The exact geographic area of OU3 has not yet been defined but will be based primarily upon the extent of contamination associated with releases from the former vermiculite mine as determined in the remedial investigation (RI) of OU3. The purpose of Part C of the Phase II SAP for OU3 is to guide the collection of data that will be used to assess the risks for ecological receptors associated with the release of mining-related contaminants to surface water, sediments, soils and biota. These data include information on sediment toxicity, benthic invertebrate community structure and function, fish populations, mammalian populations and histopathology and avian populations and histopathology. These data will be used to support an RI of OU3, the goal of which is to characterize the nature and extent of mining-related contamination in OU3, and to characterize the nature and level of risk posed by mining-related contamination to ecological receptors in OU3.

This SAP contains the elements required for both a field sampling plan (FSP) and quality assurance project plan (QAPP). This SAP has been developed in accordance with Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (EPA 2001) and the Guidance on Systematic Planning Using the Data Quality Objectives Process – EPA QA/G4 (EPA 2006). The SAP is organized as follows:

Section 1 – Project Overview
Section 2 – Background and Problem Definition

Section 3 – Summary of Phase I Data
Section 4 – Data Quality Objectives
Section 5 – Sampling Program Design
Section 6 – Sampling Method Requirements
Section 7 – Laboratory Testing Requirements
Section 8 – Analytical Methods Requirements
Section 9 – Quality Control
Section 10 – Data Management
Section 11 – Assessment and Oversight
Section 12 – Data Validation and Usability
Section 13 – References

1.2 Project Management and Organization

Project Management

EPA is the lead regulatory agency for Superfund activities within OU3. The EPA Remedial Project Manager (RPM) for OU3 is Bonita Lavelle, EPA Region 8. Ms. Lavelle is a principal data user and decision-maker for Superfund activities within OU3.

The Montana Department of Environmental Quality (MDEQ) is the support regulatory agency for Superfund activities within OU3. The MDEQ Project Manager for OU3 is Catherine LeCours. EPA will consult with MDEQ as provided for by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan, and applicable guidance in conducting Superfund activities within OU3.

EPA has entered into an Administrative Order on Consent (AOC) with Respondents W.R. Grace & Co.-Conn. and Kootenai Development Corporation (KDC). Under the terms of the AOC, W.R. Grace & Co.-Conn. and KDC will implement this SAP. The designated Project Coordinator for Respondents W.R. Grace & Co.-Conn. and KDC is Robert Medler of Remedium Group, Inc.

Technical Support

EPA will be supported in this project by a number of contractors, including:

- Syracuse Research Corporation (SRC) will assist in the development of sampling and analysis plans, in the evaluation and interpretation of the data, and preparation of the baseline risk assessments for OU3.

A Problem Formulation document has been prepared by EPA (USEPA, 2008c) which represents the systematic planning step that identifies the major concerns and issues to be considered in the ecological risk assessment (ERA) and describes the basic approaches that will be used to characterize ecological risks. The Problem Formulation identifies the ecological setting at OU3, the nature of contamination and the ecological receptors that may come into contact with contaminated media. Site conceptual models (CSMs) are developed that summarize the understanding of contaminant sources, fate and transport pathways, and exposure pathways that are possible for each group of ecological receptors. Risk management objectives for OU3 are identified as well as risk management goals and the general strategies that are available to assess risks for ecological receptors.

The Problem Formulation reviews the strategies that are available for the evaluation of risks to ecological receptors from non-asbestos and asbestos contamination at OU3. The Phase IIC SAP represents implementation of a subset of elements of the presented strategies. Additional elements may be implanted as described in additional SAPs as they are deemed useful.

3.0 SUMMARY OF PHASE I DATA

Detailed data from the Phase I investigation for both asbestos and non-asbestos analytes are provided in Attachment A. The following sections summarize the sampling and analytical results of the Phase I investigation. Data reported here include summary statistics on the detection frequency and observed levels of each analyte evaluated in each medium (surface water, sediment, mine waste, forest soil, duff, and tree bark).

In considering these data, it is important to note that detection of a chemical in a site medium may not indicate that a release has occurred, since many of the detected chemicals occur naturally in the environment. In addition, concentration values may tend to vary over geographic area and time (e.g., concentrations may potentially be higher during spring runoff than during the fall). Therefore, it is important to collect data that provide adequate spatial and temporal representativeness before comparing to benchmarks or using the data to assess potential risk to humans or environmental receptors.

3.1 Surface Water

Sampling Stations

During Phase I, surface water samples were collected at a total of 24 locations, as shown in Figure 3-1. As seen, sampling stations include a number of locations along Carney Creek, Fleetwood Creek, and Rainy Creek, including ponds and impoundments on these streams, as well as seeps and springs that were located nearby.

Chemical Analyses

All surface water samples collected during Phase I were analyzed for asbestos, metals and metalloids, petroleum hydrocarbons, anions, and other water quality parameters. In addition, several selected surface water samples were analyzed for a broad suite of other chemicals, including volatile organic chemicals (VOCs), semi-volatile organic chemicals (SVOCs), pesticides, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), nitrogen-containing compounds, and selected radionuclides. These locations were selected specifically to characterize waters generated by the confluence of flows from the upper and lower portions of the mined area. Table 3-1 lists the analytical methods that were employed, and Table 3-2 shows the analyses that were performed at each station.

Asbestos Results for Phase I

Table 3-3 summarizes the results of the analysis of surface water and seeps for asbestos (LA). Results are expressed in terms of million fibers per liter (MFL). As seen, concentration values of total LA ranged widely (more than four orders of magnitude), from < 0.1 to 125 MFL.

Figure 3-2 is a map that displays the spatial pattern of results. The highest levels were observed in samples located in ponds or impoundments, including the tailings impoundment, the Mill Pond, and the pond on Fleetwood Creek, as well as from several seeps along the south side of the mined area. Levels of LA in the ponds exceed the current MCL of 7 MFL based on particles longer than 10 um. Levels in lower Rainy Creek (below the Mill Pond) tended to be relatively low. A sample collected just upstream of the confluence of Rainy Creek and the Kootenai River was non-detect.

Nonasbestos Results for Phase I

Table 3-4 presents summary statistics on the frequency and level of analytes detected in surface water samples analyzed as part of the Phase I investigation. As seen, a number of inorganic constituents (metals, anions, and nitrogen compounds) were detected, as were several indicators of petroleum hydrocarbons, but no VOCs, SVOCs, PCBs, or PAHs were detected.

Data Quality Assessment

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3.2 Sediment

Sampling Stations

During Phase I, surface water and sediment samples were collected at a total of 24 locations, as shown in Figure 3-1. As seen, sampling stations include a number of locations along Carney Creek, Fleetwood Creek, and Rainy Creek, including ponds and impoundments on these streams, as well as seeps and springs that were located nearby.

Chemical Analyses

All sediment samples collected during Phase I were analyzed for asbestos, metals and metalloids, petroleum hydrocarbons, and several sediment quality parameters. In addition, several selected sediment samples were analyzed for a broad suite of other chemicals, including cyanide, pesticides, PCBs, VOCs, SVOCs, and PAHs. Table 3-5 lists the analytical methods that were employed, and Table 3-6 shows the analyses that were performed at each station.

Asbestos Results for Phase I

Sediment samples were divided into two fractions (coarse and fine) by sieving. Concentrations of LA in the coarse fraction were measured gravimetrically and expressed as a mass percent (grams of LA per 100 grams of coarse fraction). Concentrations in the fine fraction were measured using polarized light microscopy using a visual area estimation approach (PLM-VE). Results for PLM-VE are expressed as mass percent if the concentration is 1% or higher (Bin C). If the estimated concentration is <1%, the results are expressed semi-quantitatively, according to the following scheme:

PLM-VE Result	Range of Mass Percent
Bin A (ND)	None detected (likely < 0.05%)
Bin B1 (Trace)	LA detected, > 0% but < 0.2%
Bin B2 (<1%)	LA detected, >0.2% but < 1%

Table 3-7 summarizes the analytical results for asbestos (LA) in sediment. As seen, nearly all (22 out of 24) of the sediment samples collected contain LA. In the fine fraction, values ranged from trace (<0.2%) up to 7%. In the coarse fraction, levels generally ranged from 0.1% to 0.5%.

Figure 3-3 shows the spatial pattern of LA in the fine fraction of sediment. As shown, LA was detected in most samples, except those collected in the upper-most reaches of Rainy Creek and Fleetwood Creek. Concentrations of 1% or higher (Bin C) were detected in multiple locations. The highest levels observed were in samples collected from on-site seeps.

Nonasbestos Results for Phase I

Table 3-8 summarizes the results for analytes detected in sediment samples analyzed as part of the Phase I investigation. As seen, a number of inorganic constituents were detected, as were several indicators of petroleum hydrocarbons. The laboratory noted that the composition of some of the petroleum hydrocarbons detected did not resemble the composition expected for man-made fuels, and might be natural in origin. In addition, methyl acetate was detected in two samples, and pyrene was detected in one sample. All other chemical analytes were never detected in any sample. As noted above, it is not appropriate to draw any strong conclusions regarding whether or not a release has occurred or whether any of the values are of potential concern until additional data are collected to ensure adequate representativeness of the data.

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3.2 Mine Waste/Site Soils

Sampling Stations

During Phase I, mine waste and/or soil samples were collected at several locations as shown in Figure 3-4. These samples focused on each of the principal mine waste materials identified to date including mine waste rock, impounded tailings, and coarse tailings as well soils in the former mill area and materials used for construction of unpaved sections of Rainy Creek Road. These samples are divided into six categories:

Road	MS-1 to MS-2
Tailings Impoundment	MS-4 and M-5
Coarse Tailings	MS-6 to MS-9
Cover Material	MS-10 to MS-13; MS-21 to MS-24
Waste Rock	MS-14 to MS-20; MS-26 to MS-30; MS-32
Outcrop	MS-25; MS-31; MS-33-38

Chemical Analyses

All mine waste and soil samples were analyzed for asbestos, metals and metalloids, petroleum hydrocarbons, as well as pH, moisture content and organic carbon content. This was with the exception of outcrop samples which were not analyzed for petroleum hydrocarbons. In addition, several selected mine waste and soil samples were analyzed for a broad suite of other chemicals. Table 3-9 lists the analytical methods that were used, and Table 3-10 shows the analyses that were performed at each sampling location.

Asbestos Results for Phase I

Similar to sediment samples, mine waste samples were divided into two fractions (coarse and fine) by sieving and analyzed as described above. Table 3-11 and Figure 3-5 summarize the results of the analysis of asbestos (LA) in mine waste and soil samples. All but one soil sample (33 of 34) contained LA. Of these, two are classified as Bin B1 (<0.2%), 26 are classified as Bin B2 (0.2% to 1%), and 5 are estimated to contain levels from 2-8%.

Nonasbestos Results for Phase I

The results of the analyses of the Phase I mine waste and soil samples are provided in Table 3-12. The results listed in the table are those for analytes that were detected in at least one mine waste or soil sample. The full results of the analyses from the Phase I sampling program are included in Attachment A. Fifteen metals, eight PAHs, one pesticide (pentachlorophenol), one VOC (methylacetate), aromatic and aliphatic hydrocarbons, total extractable hydrocarbons (TEH), toluene and total purgeable hydrocarbons (TPH) were detected. PCBs and SVOCs were not detected in any of the mine waste and soil samples.

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3.3 Tree Bark

Sampling Stations

During Phase 1, samples of bark from trees at least 30 years old were collected at a number of stations located on transects that radiate away from the mine, with special emphasis on the predominant downwind direction (northeast) (Figure 3-6). All tree bark samples were collected from the side of the tree facing toward the mine site, from a height of about 4-5 feet above ground.

Chemical Analyses

The tree bark samples were ashed and analyzed for asbestos by TEM. Results are expressed as Libby Amphibole (LA) fibers per cm^2 of tree bark.

Asbestos Results for Phase I

The results for analyses of asbestos in tree bark are shown in Table 3-14 and plotted in Figure 3-7. Figures 3-8 through 3-14 plot LA concentrations in tree bark incorporating the surface topography along each transect. As shown, the data show a substantial degree of variability, but there is a general tendency for the highest values to occur in samples collected within a few miles of the mine. One exception occurs along the transect located upwind from the mine site (SL255), where the highest concentration of LA was observed in the tree bark sample collected the farthest away from the mine site. This may be attributable to sources other than releases from the mined area. It is suspected that the majority of the LA in tree bark is attributable to historic releases to air during the time the mine was active, although current and on-going releases may also be contributing.

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3.4 Forest Soils and Duff

Sampling Stations

Forest soil and duff samples were collected from approximately equally spaced locations around the perimeter of a circle with a radius of about 5 feet, centered on the same tree where the bark sample was collected (see Figure 3-6).

Chemical Analyses

The forest soil samples were divided into two fractions (coarse and fine) by sieving and analytical results were reported as described above for sediment samples analyzed for LA. Duff samples were prepared by high temperature ashing to remove organic matter. The residue was then analyzed for LA by TEM. Results for duff samples are reported as a mass fraction of the mass of asbestos in grams to the mass of dried duff in grams.

Asbestos Results for Phase I

The results for analyses of asbestos in forest soils are provided in Table 3-13 and are plotted in Figure 3-15. As seen, LA was detected in a number of soil samples located relatively close to the mined area, but was not detectable at a distance more than about 2 miles from the mined area. Only one sample collected from a location approximately 1/5 mile across gradient downwind from the mine area had levels of LA qualified in Bin C (6% MF_{LA} in the fine fraction and 1.3% MF_{LA} in the coarse fraction). The source of the LA observed at these locations is unknown, but might include a) naturally occurring outcrops of the LA-bearing ore body, b) deposition from historic airborne releases from the mine and mill, and c) water-based erosion from past and/or present materials at the mine site. If current levels of LA are found to be of ecological concern, EPA will seek to collect information to allow an estimation of the relative contribution of anthropogenic and natural sources of LA.

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The full results of the duff samples are not yet available, but preliminary data suggest that LA is observable in duff samples ~~near the mine~~.

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4.0 DATA QUALITY OBJECTIVES

4.1 Overview of the DQO Process

Data Quality Objectives (DQOs) define the type, quality, quantity, purpose, and intended uses of data to be collected (EPA, 2006). The design of a study is closely tied to its DQOs, which serve as the basis for important decisions regarding key design features such as the number and location of samples to be collected and the analyses to be performed. In brief, the DQO process typically follows a seven-step procedure, as follows:

1. State the problem that the study is designed to address
2. Identify the decisions to be made with the data obtained
3. Identify the types of data inputs needed to make the decision
4. Define the bounds (in space and time) of the study
5. Define the decision rule which will be used to make decisions
6. Define the acceptable limits on decision errors
7. Optimize the design using information identified in Steps 1-6

Following these seven steps helps ensure that the project plan is carefully thought out and that the data collected will provide sufficient information to support the key decisions which must be made.

4.2 Conceptual Site Models

The conceptual site model (CSM) is a schematic summary of what is known about the nature of source materials at a site, the pathways by which contaminants may migrate through the environment, and the scenarios by which receptors may be exposed to site-related contaminants.

Figure 4-1 presents the CSM for exposure of each general ecological receptor group (fish, benthic invertebrates, terrestrial plants, soil invertebrates, birds and mammals and amphibians) to non-asbestos mining-related contaminants. As seen, each receptor group may be exposed by several different pathways. However, not all pathways are equally likely to be important. In each CSM, pathways are divided into three main categories:

- A solid black circle (●) represents pathways that are believed to be complete, and which may provide an important contribution to the total risk to a receptor group.

- An open circle (O) represents an exposure pathway that is believed to be complete, but which is unlikely to be a major contributor to the total risk to a receptor group, at least in comparison to one or more other pathways that are evaluated.

Potentially Exposed Ecological Receptors

There are a large number of ecological species that are likely to occur in OU3 and that could be exposed to mine-related contaminants. However, it is generally not feasible or necessary to evaluate risks to each species individually. Rather, it is usually appropriate to group receptors with similar behaviors and exposure patterns, and to evaluate the risks to each group.

For aquatic receptors, organisms are grouped into 2 subgroups as ~~two groups~~:

- Fish
- Benthic macroinvertebrates

For terrestrial receptors, organisms are grouped into five broad categories:

- Terrestrial Plants
- Soil invertebrates
- Birds
- Mammals
- Amphibians

Exposure Pathways of Primary Concern

Terrestrial Plants and Soil Invertebrates. Terrestrial plants and soil-dwelling invertebrates (e.g., worms) are exposed mainly by direct contact with contaminants in soil. Exposure of plants may also occur due to deposition of contaminated dust on foliar (leaf) surfaces, but this pathway is generally believed to be small compared to root exposure.

Fish. The primary exposure pathway for fish is direct contact with contaminants in surface water. This is applicable to both asbestos and non-asbestos contaminants. Fish may also be exposed to contaminants by ingestion of contaminated prey items, and incidental ingestion of sediment while feeding. Direct contact with sediment may also occur. This is often assumed to be minor compared to the pathways above.

Benthic Invertebrates. Benthic invertebrates may be exposed to contaminants in surface water and/or sediment via ingestion and/or direct contact. Benthic invertebrates may also be exposed to contaminants via ingestion of aquatic prey items that have accumulated contaminants in their tissues. This is applicable to both asbestos and non-asbestos contaminants.

Mammals and Birds. Mammals and birds may be exposed to asbestos and non-asbestos contaminants via ingestion of soils, surface water, sediment and food. Mammals and birds may also be exposed to asbestos by inhalation exposures when feeding or foraging activities result in

- An open box represents an exposure pathway that is believed to be incomplete (now and in the future). Thus, this pathway is not assessed.

Figure 4-2 presents the CSM for exposure to asbestos. This CSM is similar to the one for non-asbestos (Figure 4-1), except that information is not generally available to characterize the relative importance of each of the various pathways by which a receptor may be exposed. For this reason, the open circle is only used for direct contact (dermal exposure) of birds and mammals with asbestos. However, it should still be understood that not all of the exposure pathways indicated by a black circle for a receptor are likely to be of equal concern.

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The following sections provide a more detailed discussion of the main elements of these CSMs.

Potential Sources of Contamination

The main sources of asbestos contamination at this site are the mine wastes generated by historic vermiculite mining and milling activities. This includes piles of waste rock and waste ore at on-site locations, as well as the coarse tailings pile and the fine tailings impoundment. These wastes may also be sources of metals and other inorganic constituents of the ore. In addition, some chemicals used at the mine site in the processing of vermiculite ore might also be present in onsite wastes, including diesel fuel, alkyl amines, fluorosilicic acid, and various other flocculants, defoamers, frothers and other reagents.

Migration Pathways in the Environment

From the sources, contaminants may be released and transported via airborne emissions, surface water transport or food chain transport.

Airborne Transport. Contaminants may become suspended in air and transported from sources via release mechanisms such as wind, mechanical disturbances and/or erosion. Once airborne, contaminants may move with the air and then settle and become deposited onto surface soils. This pathway is likely to be important for asbestos, but is thought to be of low concern for non-asbestos contaminants.

Surface Transport. Contaminants may be carried in surface water runoff (e.g., from rain or snowmelt) from the mine or other areas where soil is contaminated, and become deposited in soils or sediments at downstream locations. This pathway is equally applicable to both asbestos and non-asbestos contaminants.

Food Chain Transport. Contaminants may be taken up from water, sediment or soil into the tissues of aquatic or terrestrial organisms from water and/or sediment and/or soils and/or prey items into prey items (fish, benthic invertebrate, plants, soil invertebrates, birds, mammals). This is applicable to both asbestos and non-asbestos contaminants.

the disturbance of asbestos-contaminated soils, sediments or other media. Direct contact (i.e., dermal exposure) of birds and mammals to soils may occur in some cases, but these exposures are usually considered to be minor in comparison to exposures from ingestion (USEPA, 2003). Likewise, inhalation exposure to non-asbestos contaminants in airborne dusts is possible for all birds and mammals, but this pathway is generally considered to be minor compared to ingestion pathways (USEPA, 2003).

Amphibians. Amphibians (frogs, toads) inhabit both aquatic and terrestrial (mainly riparian) environments with early life stages being primarily aquatic and latter life stages primarily terrestrial. Amphibians in their early aquatic life stages may be exposed to contaminants in surface water via ingestion and direct contact. They may also be exposed to contaminants in sediment via ingestion and direct contact and to contaminants in aquatic prey items via ingestion. In the terrestrial (riparian) environment, amphibians may be exposed to contaminants in soils or sediments via ingestion, inhalation and/or direct contact and also as the result of ingestion of terrestrial prey items.

4.3. Data Quality Objectives

4.3.1 State the Problem

Mining operations at the Site have resulted in the release of various types of asbestos and non-asbestos to the environment, including surface water, sediment and soils. Data on the effects of asbestos (LA) and non-asbestos contaminants are not sufficient to allow for a reliable assessment of risks to ecological receptors.

4.3.2 Identify the Decision

Ultimately, the data collected during the OU3 RI is intended to help EPA decide if and what response actions, ~~if any~~, are needed to protect human and/or ecological receptors from unacceptable risks from asbestos and any other mining-related contaminants in surface water and sediment in OU3.

4.3.3 Identify the Types of Data Needed

The available strategies and elements that can be used in the ecological risk assessment are discussed as part of the Problem Formulation Document (USEPA, 2008c). The Phase IIC SAP represents implementation of a subset of elements of the presented strategies. Additional elements may be implemented as described in additional SAPs as they are deemed useful.

Several types of information are needed to support a decision regarding remedial actions based on ecological risks for the primary pathways of concern. Data needed for the ecological risk assessment at OU3 can be divided into four basic categories:

- Site-specific toxicity tests
- Observations of population and community demographics
- In-situ measures of exposure and effects

Site-Specific Toxicity Tests

For ecological receptors, direct measurements of effects on exposed receptors (~~fish, benthic macroinvertebrates~~) to site media (~~surface water, sediment~~) are used to assess risks especially for contaminants for which reliable toxicity values are not available to use in the HQ approach for evaluating measured concentration values. In site-specific toxicity tests, ecological receptors are exposed to site media of known concentrations in order to observe whether the media causes adverse effects on growth, survival, and/or reproduction in laboratory test species. At OU3, site-specific toxicity testing will be completed with site surface waters and sediments. Data from the toxicity test results will be used to establish a reliable site-specific exposure response curve. Using this relationship, it may be possible to identify reference concentrations of contaminants in water or sediment that represent the boundary between acceptable and unacceptable effects on fish and benthic invertebrates. If so, then these reference concentrations may be used in the evaluation of other site waters and sediments that have not been tested using aquatic receptors.

Surface water toxicity testing was addressed in the Phase IIA Sampling and Analyses Plan (SAP) as this medium was time-critical. Sediment toxicity testing is addressed in this Phase IIC SAP.

Population and Community Demographics

Measurements of population and community demographics are made in the field to identify if any receptor population has unusual numbers of individuals (either lower or higher than expected), or whether the diversity (number of different species) or composition of species is different than expected. Other demographics include age structure and the absence or presence of pollution tolerant species. Population and community demographic information will be collected for benthic invertebrates, fish and small mammals within OU3. These data will be compared to appropriate matched reference areas.

In-Situ Measures of Exposure and Effects

Measurements of *in-situ* exposure and effects are made on receptors collected from the field, seeking to identify if individuals have higher exposure (tissue) levels, observed lesions and/or deformities that are higher than expected. Asbestos tissue burden levels in selected tissues and the number and severity of gross and microscopic lesions will be measured and compared to matched reference areas. In-Situ measures of exposures and effects will be examined in mammals and birds.

4.3.4 Define the Bounds of the Study

Spatial Bounds

The primary focus of Part C of the Phase II investigation is the Rainy Creek watershed (including upper and lower Rainy Creek, Fleetwood Creek, and Carney Creek, as well as ponds and impoundments on these streams) and the mining site area. Part C will include an evaluation of small mammal and bird populations within the OU3 area (Figure 2-1).

The spatial bounds of the assessment will also include reference areas identified for comparison of mammal and bird populations and benthic invertebrates.

Temporal Bounds

The contamination of sediments and soils is not expected to vary by time nor animal tissue levels of asbestos.

Receptor Groups and Exposure Pathways

This Phase IIC SAP is focused on a subset of the possible exposure pathways identified for ecological receptors to asbestos and non-asbestos contamination at Libby OU3. The receptor groups and exposure pathways addressed include exposure for benthic invertebrates to contaminants in sediments, exposure for fish to contaminants in surface water and sediments, exposure for mammals and birds to contaminants in all media. Other receptor groups and exposure pathways may be addressed in other SAPs.

4.3.5 Define the Decision Rule

In the baseline ecological risk assessment, risks to ecological receptors from a particular chemical in a particular medium will be evaluated using a weight-of-evidence approach, combining the results from four possible lines of evidence:

- Calculation of Hazard Quotient (HQ) values based on measured concentration values and available toxicity reference values (TRVs)
- Exposure of test organisms to environmental media samples(surface water and/or sediment) collected from the site to evaluate the magnitude and frequency of any effects on growth, reproduction or survival
- Direct surveys of receptor population and community demographics in comparison to appropriate reference areas
- Direct measurement of receptor exposure and effects in comparison to appropriate reference areas

The weight-of-evidence conclusions will take many factors into account, including the strengths and weaknesses of each line of evidence, and the degree of agreement between the different lines. Thus, no statistical or quantitative decision rule can be stated *a priori*. The following guidelines will be applied when interpreting risks to each ecological receptor of concern:

- If all lines of evidence agree there is <u>not</u> a risk. If the calculated HQ does not exceed 1 for acute or chronic toxicity, there are no significant growth, mortality or reproduction effects observed in site-specific toxicity tests (compared to reference and laboratory controls), there are no ecologically relevant differences observed in direct surveys of population and community demographics (compared to reference(s)) and there are no ecologically relevant differences observed in direct measurements of exposure and effects (compared to reference(s)), then remedial actions to protect ecological receptors ~~will~~ are not likely to be necessary.

- If all lines of evidence agree there is a risk. If the calculated HQ exceeds 1 for acute or chronic toxicity, there is evidence of site-specific toxicity, there is evidence of an adverse impact to population and community structure and function, and there is evidence of in-situ exposure and effects, then remedial actions to protect ecological receptors are likely to be necessary.

- If the results from each line of evidence are mixed (e.g., HQs exceed 1 but direct toxicity is not observed), greatest weight will be placed on <u>site-specific toxicity tests</u>, <u>population and community demographic observations</u> and *<u>in-situ</u>* <u>measures of exposures and effects</u>. The weight assigned to the predictive (HQ) approach will be in proportion to confidence in the exposure estimates and in the toxicity reference value (TRV) used to derive the HQ values.

- If the available lines of evidence are limited, the weight assigned will be in proportion to the confidence in the data for each line of evidence. The ecological decision rule will likely take the form that, if the weight-of-evidence indicates that adverse effects on ecological receptors are occurring, and that these effects are likely to result in a meaningful decrease in the growth, reproduction or survival of local populations compared to what would be expected in the absence of site-related contamination, then a response action will be appropriate.

4.3.6 Define the Acceptable Limits on Decision Errors

Two types of decision errors are possible when making risk management decisions:

- A <u>false negative</u> decision error occurs when it is decided that risk is acceptable when the true risk is actually above the level of concern

- A false positive decision error occurs when it is decided that risk is not acceptable when the true risk is actually below the level of concern

Of these two types of errors, EPA is primarily concerned with avoiding false negative errors, since an error of this type can leave human or ecological receptors exposed to unacceptable levels of contamination and risk. The EPA usually identifies 5% as the maximum acceptable probability of making a false negative decision.

A false positive decision error does not leave ecological receptors at risk, but is also of concern to EPA because this type of error may result in the expenditure of resources (time, money) that might be better invested elsewhere. For the OU3 RI and risk assessment process, the goal is as follows: if the true level of risk is less than ½ the acceptable risk level, then there should be no more than a 20% chance that the risk will be declared to be unacceptable.

4.3.7 Optimize the Design

Risks to ecological receptors, including fish, benthic invertebrates, small mammals and birds will be based on a weight of evidence evaluation. Consequently, it is not possible to develop statistical rules that limit the likelihood of false positive or false negative decision errors. Rather, the degree of confidence in the decision is based on the quality of the data available, and the degree to which different lines of evidence yield consistent conclusions. If multiple lines of evidence support the same conclusion, then confidence in the decision is increased. Conversely, if different lines of evidence yield inconsistent conclusions, then confidence in the decision is decreased.

HQ Approach

It is common to begin by an assessment of risks using the HQ approach. Note, however, that this requires the availability of suitable toxicity reference values (TRVs) for the contaminants of concern. Such TRVs do exist for most non-asbestos analytes, and the HQ approach will be used as the first line of evidence for this group of contaminants. If the HQ results suggest that risks are below a level of concern, then no further evaluation will be needed. If the HQ approach suggests that risks may be occurring, then other lines of evidence will be investigated.

In the case of asbestos, no TRV values are currently available for any ecological receptor group. Even if such values were available, their relevance to OU3 would be uncertain because the toxicity of asbestos may depend on the mineral type (LA) and on the particle size distribution in site waters. For this reason, the first line of evidence evaluated will be site specific toxicity testing. This may provide direct data on the toxicity of site sediments to an appropriate benthic species. Assuming that the site sediment samples produce toxicity, then a site-specific TRV can be developed by either analyzing the testing results. The resultant site-specific TRV may then be used to predict, using the HQ approach, the expected toxicity of LA in other site sediments that

have not been tested. A similar approach was used to evaluate the toxicity of LA in surface water as part of the Phase IIC SAP.

Optimize the Sampling Design for Site-Specific Toxicity Testing

The objective of site-specific toxicity testing with sediments is to develop a site-specific exposure-response curve for toxicity to benthic invertebrates. This is best achieved by testing sediments at regularly-spaced concentration intervals ranging from low to high. Sediment samples will be selected based on Phase I and Phase IIA data to reflect a range of asbestos and non-asbestos contaminants. Site-specific toxicity testing with LA in surface water was addressed in the Phase IIA SAP.

The sediment results for LA from Phase I (Table 3-8) can be stratified into the following bins (seep samples on Carney Creek not included) based on the amount of asbestos:

PLM-VE Result	Range of Mass Percent	Sampling Station
Bin A (ND)	None detected (likely < 0.05%)	URC-1, FC-1
Bin B1 (Trace)	LA detected, > 0% but < 0.2%	FC-2
Bin B2 (<1%)	LA detected, >0.2% but < 1%	URC-2 , TP, MP, LRC-1, LRC-2, LRC-4, LRC-5, LRC-6, FC-Pond, CC-2
2%	LA detected >1%	LRC-3, TP-TOE1
3%	LA detected >1%	TP-TOE2
4%	LA detected >1%	CC-1

It appears that the highest concentrations of LA were found at the toe of the tailings pond, Lower Rainy Creek (at LRC-3) and upper Carney Creek (CC-1). For surface waters, the highest concentrations of LA tended to occur in the ponds and impoundments, and also in the influent waters to those ponds (USEPA, 2008b).

Based on a review of the Phase 1 data (Table 3-13 and USEPA, 2008c) a few metals had concentrations above screening benchmarks (chromium, lead and nickel). The most notable of these was chromium with concentrations ranging up to 988 ppm (at CSS-8). The high chromium concentrations seem to be co-located with high asbestos. Chromium was detected at greater than 200 ppm at four locations where asbestos was detected at >1% (TP-TOE2, LRC-3, CCS-9, CCS-8, and CCS-6). There was only one sampling location (FC-Pond) where chromium was detected at >200 ppm with low concentrations (> 0.2% but <1%) of asbestos and two sampling locations (TP-TOE1 and CC-1) where high asbestos was measured with lower chromium (< 50 ppm).

To optimize the study design, the following stations are selected for the collection of sediment samples for toxicity testing to represent the range of asbestos exposure concentrations as well as chromium:

- Non Detect to Trace Amounts of Asbestos (URC-2 and FC-2)

- Lower Amounts of Asbestos (> 0.2% and < 1%) (LRC-1; and FC-Pond)
- Low Asbestos (> 0.2% and < 1%) and high chromium (>200 ppm) (FC-Pond)
- 2% Asbestos (LRC-3)
- 4% Asbestos and low chromium (<50 ppm) (CC-1)
- Reference (Ref-1)

To optimize the study design, the following stations are selected for sediment toxicity testing to allow for a weight-of-evidence approach (multiple lines of evidence) to assess risks in lower Rainy Creek:

- LRC-5

Optimize the Sampling Design for Population and Community Demographics

Population and community demographic information will be collected for benthic invertebrates, fish, small mammals and birds and compared to those collected in reference areas. The objective is to identify if any receptor population has unusual numbers of individuals (either lower or higher than expected), or whether the diversity (number of different species) of a particular category of receptors (e.g., benthic organisms, fish, mammals) is different than expected.

For benthic invertebrates, the benthic community will be sampled at locations along Fleetwood Creek, Carney Creek, and Rainy Creek that are concurrent with the Phase I and Phase IIA surface water and sediment sampling locations. This will optimize the ability to interpret community metrics versus contaminant concentration. The objective is to identify if metrics are different in comparison with reference areas and if any observed changes could result from contaminant exposures. The reference area(s) will be identified to match as closely as possible the habitat variables present at the aquatic sites being evaluated. Note that, because asbestos contamination may have been transported by air from the mine site area to upstream locations along Rainy Creek, upstream locations may not be an appropriate reference. The methods for benthic invertebrate collections will include those that have been used by the United States Forest Service in the Kootenaii National Forest. This will optimize comparison of data collected at OU3 with those collected in other streams in the National Forest over a several year period.

For fish, surveys will be performed at selected locations within the Rainy Creek drainage that are concurrent with the Phase I and Phase IIA surface water and sediment sampling locations. As with the benthic invertebrate sampling, fish will be collected at stations that are concurrent with surface water and sediment sampling locations. Fish species and number (density) are noted and compared to matched reference locations.

Optimize the Sampling Design for In Situ Measurements of Exposure and Effects

In-situ measurements of exposure and effects will be examined in mammals and birds collected from the following areas:

- Disturbed area on the mine site where asbestos levels in soils are highest
- In a forested area near the mine disturbed area where asbestos levels are lower in soils compared to than the mine site proper and more habitat is available.
- In a ~~riparian area near the Tailings Impoundment~~ second tier / Next year
- In a reference area upwind of OU3 in a similar forested habitat type.

Leave for now but I think this might be better next year.

A reference area will be selected that is matched as closely as possible to the forested area within OU3. The objective of the *in-situ* measurements is to identify if asbestos tissue burdens, the frequency and severity of gross pathology and/or histopathological lesions in selected tissues are greater than reference areas.

5.0 SAMPLING PROGRAM DESIGN

Table 5-1 provides an overview of the data collection activities that will be performed under Phase IIC of the OU3 RI. The following sections provide descriptions of the general experimental design for each of the Phase IIC elements. Specific details with regard to sampling method requirements, laboratory testing requirements and analytical methods are provided in subsequent sections.

5.1 Site-Specific Sediment Toxicity Testing Methods and Procedures

Why just C? Is 15 to core enough?

One of the most direct methods for evaluating toxicity of site media such as surface water and sediment to ecological receptors is through site-specific toxicity testing. In this approach, test organisms are exposed to site media in the laboratory to determine if the site media causes adverse effects on survival, growth and/or reproduction. Figure 5-1 provides a conceptual flow diagram for sediment toxicity testing. As shown, the approach is similar to that used for surface water in the Phase IIA SAP (USEPA, 2008b) (Figure 5-2), except that a dilution series is not needed because sediments will be collected from a range of locations that span a wide range of both asbestos and chromium concentrations. Sediments will be collected from eight locations in the Rainy Creek Watershed including two in Fleetwood Creek (FC-Pond, FC-2), one on Carney Creek (CC-1), one on Upper Rainy Creek (URC-2), three on lower Rainy Creek (LRC-1, LRC-3, and LRC-5) and one from a reference area (Ref-1) (Table 5-2). As described previously, the locations were selected to test the range of observed asbestos concentrations with the goal of identifying a toxicity value for sediments that is protective of benthic organisms. In addition to the samples within OU3, samples will also be collected for testing from a reference area.

Sediments will be collected as a composite of grab samples. Two laboratory test organisms will be exposed (the amphipod *Hyalella azteca* and midge *Chironomus tentans*) to the sediment samples in the laboratory and survival, growth and reproduction examined over a 42-d period. All sediment samples will be analyzed for asbestos and TAL metals. The Phase IIA sediment sampling and analyses results will be examined to identify any additional analyses are necessary.

5.2 Population and Community Demographic Observations

5.2.1 Benthic Invertebrates

Benthic invertebrates will be collected at 12 stream locations (Table 5-2) including one in upper Rainy Creek (URC-2), six in lower Rainy Creek (LRC-1 to LRC-6), two in Fleetwood Creek (FC-1 and FC-2), two in Carney Creek (CC-1 and CC-2) and one at a reference location (Ref-1). Benthic invertebrate samples would be collected at the same locations as sediment and surface water samples to facilitate an analysis of the correlation between community status and contaminant level. Samples would be collected according to an established EPA *Rapid Bioassessment Protocol* (RBP) (USEPA, 2003). For each sampling location, a number of alternative metrics of benthic community status will be calculated and combined to yield a Biological Condition Score. A number of alternative measures of habitat quality will also be measured to yield a Habitat Quality Score (a comparison of the Biological Condition Score to the Habitat Quality Score provides information on the likely contribution of non-habitat factors (e.g., chemical pollution) on the benthic community). The scores and individual metrics will be examined to identify if the community is impacted relative to reference and if there are any apparent trends in condition with asbestos concentrations. This method does require the selection of at least one appropriate reference area for comparison. The reference area will be selected to match as closely as possible the habitat variables present at the aquatic sites being evaluated. Note that, because asbestos contamination may have been transported by air from the mine site area to upstream locations along Rainy Creek, upstream locations are not an appropriate reference.

5.2.2 Fish

Fish will be collected at the same sampling locations identified for collection of benthic invertebrates as well as some additional locations. In addition to the benthic invertebrate locations, fish will also be collected from the Mill Pond, Tailings Pond and Fleetwood Creek Pond (Table 5-2). For each sampling location the following information will be recorded:

- The species identified
- The number of individual fish
- The size class structure of the fish collected by weight and length
- The ratio of males to females
- The frequency of any identified external abnormalities.

These results will be compared to those collected from the reference area.

5.2.3 Mammals and Birds

Quantitative surveys of mammalian and avian density and diversity are difficult to perform because of the high natural variability in receptor density over space and time. For this reason, formal population surveys will not be attempted at this time. However, semi-quantitative data in the form of number of organisms of each species collected per trapping day will be available from the field collection effort for the measurement of In-situ exposure and effects (Section 5.3) from both on-site locations and reference locations. Comparison of these trapping rates will provide an initial impression as to whether population densities are likely to be similar or dissimilar in site areas compared to reference areas. If evidence of an apparent difference is obtained, this may be followed with more quantitative efforts to compare population demographics, depending on the overall weight of evidence available.

5.3 In-Situ Measures of Exposure and Effects

In this line of evidence, mammals and birds will be collected from site locations (on-site, forest area, riparian area, surface water bodies) and examined for gross and microscopic pathological effects. The incidence and severity of effects observed will be compared to organisms from suitable reference areas, and are also will be analyzed for possible correlations with the relative concentrations of LA in tissues and the collection area. These data will help define the spatial extent of LA contamination that can impact wildlife. Interpretation of the ecological consequences of any gross or histological lesions that are observed will be based on literature information that associates the pathology effects with adverse effects on growth, reproduction, and survival, as well as on consultation with experts in the field. In-Situ measures of exposure and effect are discussed for receptor groups in the following subsections.

5.3.1 Fish

A subset of the fish sampled for population and community demographics from the site and reference areas will be collected to assess the level of exposure via measures of asbestos body burden, and the level of effect via the frequency and severity of histological lesions. The subset of sample locations include one in upper Rainy Creek (URC-2), three in Rainy Creek (LRC-1, LRC-3 and LRC-5), one in Fleetwood Creek (FC-1), one in the Tailings Pond (TP-1), and one at a reference location (Ref-1). This is implemented simply by selecting fish that are captured for the fish community survey (Section 5.2.2), and collecting and preserving tissues from these fish for potential future analysis.

The Phase IIA SAP (USEPA, 2008c) specifies toxicity testing with LA in the laboratory with rainbow trout. These exposed fish will be examined for histopathology ~~and LA tissue burdens~~. At this time, measurement of LA tissue burdens and gross and microscopic lesions in fish is not proposed at this time. Analyses of these measurements in field collected fish will be assessed

Not ←

This section is confusing. Is second paragraph in reference to tox test or field collected fish? 1st para says CA/histo will be done, 2nd says samples will be preserved. I'm confused.

based on a review of the laboratory data. However, since fish will be collected and effort expended to assess the status of fish populations and the fish community, samples of fish tissue will be collected from this survey, preserved and held for possible future analyses.

Gross and Microscopic Lesions

For a subset of the fish collected during the population survey, a gross necropsy will be performed to identify any gross external or internal lesions. After the necropsy, specific target tissues will be removed & preserved for possible future histopathology examination. Lesions that have been reported in the literature following exposure of aquatic organisms to asbestos are summarized in Table 5-3. Based on this data, the target tissues for histopathology examination include the lateral line, gill, kidney and gastrointestinal tract.

At seven of the sixteen sampling locations identified for fish community surveys (Table5-2), ten fish representing at least two different species will be examined for gross necropsy and target tissue collection. This subset of sampling locations represents a range of asbestos exposure concentrations in surface water and sediment. The target tissue samples will be preserved and held for possible future analyses.

If these samples are examined and the approach is implemented, the incidence and severity of effects observed in fish from on-site locations would be compared to that observed in organisms collected from an appropriate reference area, and also to the concentrations of asbestos in surface water and sediment at the sampling stations in an effort to establish a dose-response relationship. Consequences of the measured pathology effects will be evaluated based on literature information that associates the pathology effects with adverse effects on growth reproduction and survival as well as the results of the laboratory testing completed as part of the Phase IIA SAP.

Tissue Burden

If the histopathology samples are examined then measurements of LA tissue burden in the collected tissues (lateral line, gill, kidney and gastrointestinal tract) will also be performed. Tissue to be analyzed will be weighed (wet weight) and then dried and ashed. The ashed residue will be resuspended in acid and water and an aliquot deposited on a filter for analysis by TEM. Results would be expressed as fibers of LA per gram (wet weight) of tissue. The tissue samples to be analyzed would be split samples of those collected and preserved for histopathology. The tissue samples to be analyzed will be split samples of those collected and preserved for histopathology. Samples will be submitted for asbestos analysis using transmission electron microscopy (TEM) in accord with the International Organization for Standardization (ISO) 10312 method (ISO, 1995).

5.3.2 Mammals

At present, one of the few lines of evidence available to evaluate risks to wildlife from asbestos is the *in-situ* measurement of exposure and effect in organisms collected from the site. This technique (Figure 5-3) has the advantage that it allows measurement of exposure and effects by both oral and inhalation exposures, and may allow development of maps that indicated the relative levels of exposure as a function of location. The chief disadvantage of this method is that the *in-situ* measures of exposure and effect are not easy to extrapolate to effects on growth, reproduction and survival, and hence on population stability.

Sampling Locations (Trap Areas)

Four areas are identified for small mammal trapping. These locations are listed in the following table along with the rationale for their selection. The exact locations of the sampling areas and placement of trap lines will be made during the initial field reconnaissance based on the identified habitats, terrain, access and other considerations.

Location ID	General Descriptions and Rationale	General Identified Areas
SMT-1	On the Mine Site Disturbed Area. This area is expected to have highest the highest asbestos exposures but not the best habitat to support species.	MW-6 or MW-16
SMT-2	Near the disturbed Mine Site Area in an area with better habitat than SMT-1 with known asbestos contamination in soils, tree bark and duff.	Near SL-45-01
SMT-3	Riparian area near water body with both established use by waterfowl and/or shorebirds and known asbestos contamination in sediments and/or surface water.	Tailings Pond
SMT-Ref	Reference area with habitat matched closely in terms of vegetative cover and elevation to SMT-2.	Area upwind of OU3 to the west

Trap Method

Methods for capturing mammals and in particular the use of trap arrays are reviewed by Jones et al., 1996. Typical methods of trap placement include transects, grids and webs (Wilson et al.,' 1996). Pearson and Ruggiero (2003) compared transect versus grid trapping arrangements for sampling small mammal communities in two forest cover types in west central Montana. They found that transect arrangements compared to grid arrangements yield more total captures, more individual captures and more species than grid arrangements in both cover types in both of the years examined. Differences between the two methods were greatest when small mammals were least abundant. Based on this reported efficiency and the lower level of effort required for the line transect method compared to the grid method, the line transect trap method will be used to collect small mammals at Libby OU3.

In the line transect method; traps are placed at equal intervals along a line which is located randomly within a habitat type. More than one line may be located within a habitat type (sampling location). Traps should be placed at habitat features (e.g., log, tree, runway, burrow) as long as they lie within 2 meters of the point. Wilson et al. (1996) recommends placing two traps at each trap point to avoid the saturation of traps with "trap-happy" individuals that are readily captured. The practice increases the chances that animals that are less active or less attracted to traps to be caught.

Is this section misplaced? Should it include mammals & Birds? New header?

Target Species

In order to implement this approach, it is first necessary to identify the classes of wildlife that are likely to be maximally exposed. The most important selection criteria include the following:

- Non-transitory. Some organisms migrate over long distances, and are present in the area of the site for only a short time each year. Because of the brief interval they would be exposed, such organisms would have less exposure than organisms that are present year round or for most of the breeding season.

- Small home range. Organisms that have a large home range are likely to spend a small part of their time in and about the most heavily impacted areas of the site. Consequently, they are likely to be less exposed than organisms that have a small home range and spend a high fraction of their time in and about the impacted areas.

In addition to these two baseline factors, there are a number of other factors that may also influence the relative level of exposure, including the following:

- Foraging strategy – Species that forage on the ground and have a greater potential to disturb asbestos fibers are expected to have more inhalation exposure than those that forage in shrubs or tree foliage. Species that feed in flight on insects and carnivores that prey on other mammals and birds are expected to be less exposed. Species that forage on aquatic organisms and fish would also be less exposed because inhalation exposures require the disturbance of fibers which is less likely under wet conditions.

- Habitats and Nesting – Where species find shelter, give birth (or nest) and/or rear young may also influence exposures. Many species burrow into the ground or create shallow runs under forest litter. Some others will create nests/dens in existing cavities of barren rock or dead trees. Burrowers are expected to receive higher exposures compared to those species that live higher in trees.

- Body Size – Ingestion rates and breathing rates per unit body weight tend to be higher for species with small body weights compared to species with higher body weights. Thus, exposure by both oral and ingestion pathways may be highest for small receptors.

- Longevity In humans, it is well established that risk of adverse effects is a function of cumulative exposure. That is, risk depend both on exposure level and also on exposure duration. For this reason, organisms that have longer life spans will tend to have higher cumulative exposures and hence may be more likely to display adverse effects from asbestos exposure.

Taking these factors into account, the feeding guilds and species identified as residing within the area of Libby OU3 (listed in Attachment A of USEPA 2008c) were evaluated in order to identify a list of receptors most likely to have high exposures to LA, as follows:

1) Species inhabiting terrestrial and riparian habitats were segregated into two groups based on habitat type (terrestrial and riparian).
2) Because exposures to asbestos for species inhabiting riparian habitats are expected to be primarily related to ingestion of aquatic food items as well as surface water and sediments, the riparian species were segregated into two exposure groups by feeding guild. These include aquatic invertivores/omnivores and piscivores.
3) For species that inhabit terrestrial habitats, those that forage on the ground and or inhabit nests or burrows were identified from the larger list and classified into a "ground" foraging group. These species are expected to be the highest exposed to asbestos via inhalation and ingestion as a result of probing and disturbing asbestos in soils and ground litter.
4) Species that forage primarily in trees and shrubs were identified from the larger list and classified as an "arboreal" foraging group. These species may be exposed to asbestos on tree bark or leaf surfaces as result of foraging for food.
5) Carnivorous species were identified and placed in separate group based on feeding guild. These species are expected to be exposed to asbestos primarily via ingestion and inhalation exposures are expected to be lower than those species that forage on the ground for food.
6) The ground and arboreal groups were further stratified into feeding guilds (invertivore, grainivore, omnivore, carnivore) to reflect exposures related to ingestion.
7) The species in each group were then reviewed further and those with small home ranges and small body sizes were selected preferentially. These species are expected to be maximally exposed to asbestos impacted area and will not range in and out of the area.
8) For avian species, birds that are transients (occurring at the site only during spring or fall migrations) were excluded, while birds that are resident year round or are present for extended periods during the warm weather were retained.

Pocket Gopher 18-24 mo Woodrats ♀ maturity ≈ 1 yr
Deer Mouse < 12 mo marmot
Columbian ground squirrel

captured in a snap trap, it becomes a likely target for predation. The heavier box trap, with solid sides, is better suited to withstand disruption by predation. Live trapping is also preferred for the collection of samples for histopathology examination. Animals collected from kill traps may decompose prior to collection making tissue examination impossible.

Trapping Effort

Trapping effort is the product of the number of traps used and the time over which those traps are monitored. The number of traps multiplied by the number of "trap-nights" gives the number of "trap-nights" for a particular study. Wilson et al. (1996) recommends a minimum of 500 trap nights for a preliminary investigation of a habitat. Data from studies with similar trapping effort can be compared using relatively simple models the include capture indices and abundance indices.

Wilson et al. (1996) recommends a trap transect be at least 150 m long with traps placed every 10 to 15 m. A general rule is to space traps at a distance no greater than the radius of a circle having an area equal to that of the average home range (if known) of the target species. The deer mouse is the most likely organism to be collected based on the data evaluated in the Problem Formulation (USEPA, 2008b). This species has a reported home range averaging 1 hectare or less and may range from a few hundred to a few thousand sq m (http://www.natureserve.org/). Based on this information of trap spacing of 10 meters is more than adequate for a 200 square meter home range.

The targeted trapping effort at Libby OU3 will be 450 trap nights for the Phase IIC SAP. Three 150 m line transects will be established at each of the sampling locations and traps placed (2 each) at 10 m intervals and collected over a five day period of time. This design will result in a 450 trap night effort per sampling location. The trapping effort (time) required to complete a species inventory can be determined with a species accumulation curve, a plot of cumulative number of species captured versus cumulative trapping effort. When the curve reaches a plateau, or when the capture of species or individuals no longer increases with additional effort, the trapping effort may be adequate. If this plateau is reached prior to the 5 day trapping period and the targets for collection of individual animals and species for tissue collection is met, then the trapping effort may cease earlier.

Measurements

For each of the mammals collected, the species, weight and any notes of physical abnormalities will be recorded. If possible age will also be recorded. This information will be used to calculate statistics on abundance and species diversity. The results for the OU3 sample areas (SMT-1, -2 and -3) will be compared to the reference area (SMT-Ref).

A subset of the mammals collected will be sacrificed for the examination of gross and microscopic lesions in the lungs, gastrointestinal tract, and kidney. The following targets are identified for histopathology examination:

Table 5-4 provides the list of species that meet the selection criteria above. The following table summarizes the categories of receptor groups that are likely to be maximally exposed in each exposure area.

Location	Exposed Receptor Group	Exposure
Mined area and Forest area	Ground Invertivore	Ingestion of asbestos in soil invertebrates and inhalation of asbestos in soil during disturbance.
	Ground Herbivore/Omnivore	Ingestion of asbestos in/on plant material and inhalation of asbestos in soil during disturbance.
Riparian area	Aquatic Invertivore/Omnivore	Ingestion of asbestos in aquatic plants, aquatic invertebrates and/or sediments.

The targeted mammalian species for collection in the mined area and forested area are the ground foraging species (invertivore, herbivore, omnivore). The targeted species in the riparian area are aquatic invertivores and omnivores. Any protected species (Table 5-5) captured will be released. Table 5-4 provides the list of ground invertivores, ground herbivores and omnivores and aquatic invertivore and omnivores that may be in the OU3 area.

In nine west-central Montana forest stands (five dominated by old-growth ponderosa pine (*Pinus ponderosa*) and four by western larch (*Larix occidentalis*) over 22, 752 trap nights, the most commonly collected species were deer mice (*Peromyscus maniuclatus*), southern red-backed voles (*Clethrionomys gapperi*), and red-tailed chipmunks (*Tamias ruficaudus*) (Pearson and Ruggiero, 2003). Yellowpine chipmunk (*Tamias amoenus*), golden-mantled ground squirrel (*Spermophilus lateralis*), vagrant shrew (*Sorex vagrans*), dusky or montane shrew (*Sorex monticolus*), snowshoe hare (*Lepus americanus*) and red squirrel (*Tamiasciurus hudsonicus*) were also collected but less frequently (Pearson and Ruggiero, 2003). This information agrees with the reported frequency of sightings of ground dwelling small mammalian species as reported in the Montana Tracker (numbers listed in Table 5-4). The most common ground herbivore/omnivore reported in Lincoln county are the deer mouse and the southern red-backed vole which are the two most common species captured in the trapping completed by Pearson and Ruggiero (2003). This agreement provides an indication of what species to expect to be trapped using line transect trapping and Sherman traps at Libby OU3.

Trap Type

While many types of traps are available for the collection of small mammals, the small mammal collection at Libby OU3 will use Sherman Live traps. Sherman Live traps are a type of box trap that are the most effective for capturing small terrestrial mammals unharmed (Wilson, 1996). This trap is rectangular in shape with a spring-loaded door that becomes triggered once an animal enters the trap. Box traps are recommended over simple snap traps (or kill traps) due to reduced occurrences of predation and trap disturbance by raccoons and deer. Snap traps are lightweight and easily triggered or moved by non-target species. In addition, once an animal is

- For each sampling location (SMT-1, -2, -3, SMT-Ref) at least 15 individuals within the ground herbivore/omnivore group will be examined
- Any shrews captured will be examined (ground invertivore exposed receptor group or aquatic invertivore/omnivore receptor group) at up to 10 individuals per sampling location)
- Similar species (within the ground herbivore/omnivore) group will be examined across sampling locations at SMT-1, -2 and SMT-ref with a goal of at least three species
- For riparian species the goal is two species
- Any arboreal invertivore collected will be examined (up to 10 individuals per sampling location)

Based on available information as previously discussed the most common species expected in the collections are the deer mouse and southern red-backed vole which are within the ground herbivore/omnivore receptor group. Pearson and Ruggiero (2003) did have some success capturing shrews using the Sherman traps with the vagrant shrew and dusky shrew being the sixth and seventh most frequently captured mammal. Shrew capture at OU3 is possible.

Initial Field Reconnaissance

Prior to the small mammal trapping, an initial field reconnaissance will be completed to confirm the exact sample locations for the collection effort. This reconnaissance will also allow for arrangement of the logistics necessary for the mammal and bird collections and the initial placement of traps "opened". This is part of the small mammal sampling procedure where traps are placed 6 days prior to the start of collections to accustom the animals in the field to their presence.

Gross and Microscopic Lesions

A large number of studies have been performed in mammals to identify the effects of inhalation exposure to asbestos on the respiratory tract, and, to a lesser degree, the effects of inhalation and ingestion exposure on other organs (e.g. gastrointestinal tract). In animals, histological signs of tissue injury can be detected at the site of deposited fibers within a few days (ATSDR, 2001). Ingestion exposures have been associated with lesions in the parathyroid tissue, brain tissue, pituitary tissue, endothelial tissue, kidney tissue, and peritoneum tissue (Cunningham et al., 1977). Induction of aberrant crypt foci in the colon (Corpet et al., 1983) and tumors of the gastrointestinal tract have also been reported. Inhalation exposures are associated with fibrosis, lung tumors and lesions along the respiratory bronchioles, alveolar ducts, alveoli, and lung tissue (McGavran et al. 1989; Donaldson et al. 1988; Davis et al., 1980a, 1980b, 1985, 1986). Mesotheliomas have been observed (Davis and Jones 1988, Davis et al. 1985, Wagner et al. 1974, 1980, Webster et al. 1993). Based on this information the target tissues for histopathology examination in mammals include the lungs, gastrointestinal tract, and kidney.

Mammals collected from each of the sampling areas and sacrificed for examination will be examined for gross pathology and microscopic pathological effects in the target tissues (lungs, gastrointestinal tract and kidney). The incidence and severity of effects observed will be compared to those from the reference area, and will also be correlated with the relative concentrations of LA in duff in the collection area. These data, combined with the tissue burden data, will help define the spatial extent of LA contamination that can impact wildlife. Interpretation of the ecological consequences of any gross or histological lesions that are observed will be based on literature information that associates the pathology effects with adverse effects on growth, reproduction, and survival, as well as on possible consultation with experts in the field.

Tissue Burden

Selected organs (lungs, gastrointestinal tract and kidney) of mammals collected at the site will be analyzed for asbestos tissue burden. Tissue burden in lung will be interpreted as an indication of inhalation exposure, and tissue burden in the gastrointestinal tract and kidneys will be taken as an indication of oral exposure. Comparison of the tissue burdens from OU3 sample locations and the reference location will be used to establish an estimate of the spatial extent of LA exposures recognized as being higher than background.

LA tissue burden in the collected tissues (lungs, gastrointestinal tract and kidney) will be determined. Tissue to be analyzed will be weighed (wet weight) and then dried and ashed. The ashed residue will be resuspended in acid and water and an aliquot deposited on a filter for analysis by TEM. Results would be expressed as fibers of LA per gram (wet weight) of tissue.

Samples of Duff for Asbestos Content

Samples of duff will be collected at a sub-sample of the trap locations along each sampling transect for the analyses of asbestos content. These samples will be spaced 30 m apart along each of the three small mammal sampling transects within each general sampling location. This effort across the four sampling locations will total 60 samples. The information will be used to investigate if any correlation exists between the asbestos content observed in duff and the extent and/or severity of histopathological lesions observed in any of the target tissues. As described in prior sampling efforts and the Problem Formulation for Ecological Risk Assessment (USEPA, 2008c), the analyses of asbestos in duff (an organic sample) is more quantitative and informative compared to analyses of asbestos in forest soils. Therefore, the sampling of forest soils is not recommended as part of the Phase IIC investigation.

5.3.3 Birds

At present, one of the few lines of evidence available to evaluate risks to wildlife from asbestos is the *in-situ* measurement of exposure and effect in organisms collected from the site. This